Claims

[c1] A bi-directional signal interface comprising:
a first waveguide having one end that is coupled to a RF input port that receives a RF transmission signal and having another end that is coupled to a RF bi-directional port that receives a RF reception signal and that transmits the RF transmission signal, the first waveguide propagating a first traveling wave;
a second waveguide having one end that is coupled to an output port that passes the received RF reception signal, the second waveguide propagating a second traveling wave; and
a non-reciprocal coupler that couples fields from the first waveguide to the second waveguide, wherein the RF reception signal from the RF bi-directional port couples from the first waveguide to the second waveguide in a substantially non-reciprocal manner and then passes through the output port, and the RF transmission signal from the RF input port passes through the first waveguide to the RF bi-directional port.

[c2] The signal interface of claim 1 wherein substantially all of the RF transmission signal from the RF input port

passes through the first waveguide to the RF bi-directional port.

[c3] The signal interface of claim 1 wherein substantially all of the RF reception signal from the RF bi-directional port couples from the first waveguide to the second waveguide in the substantially non-reciprocal manner.

[c4] The signal interface of claim 1 wherein the first and the second waveguides and the non-reciprocal coupler comprise an electro-optic modulator.

[c5] The signal interface of claim 1 wherein the first and the second waveguides and the non-reciprocal coupler comprise an electrical distributed amplifier.

[c6] The signal interface of claim 1 wherein the non-reciprocal coupler comprises an electrode structure that velocity matches at least one of the RF reception signal and the RF transmission signal to at least one of the first and the second traveling wave.

[c7] The signal interface of claim 1 wherein the RF bi-directional port receives the RF reception signal and passes the RF transmission signal with full duplex operation.

[c8] The signal interface of claim 1 wherein the RF bi-

directional port receives the RF reception signal and passes the RF transmission signal with half-duplex operation.

[c9] The signal interface of claim 1 further comprising a photodetector having an optical input that receives an optical transmission signal and an electrical output that is connected to the RF input port, the photodetector converting the received optical transmission signal to the RF transmission signal at the electrical output.

[c10] The signal interface of claim 1 further comprising an antenna that is electrically connected to the RF bi-directional port.

[c11] A method of interfacing a reception signal and a transmission signal, the method comprising:
propagating a first traveling wave through a first waveguide and propagating a second traveling wave through a second waveguide;
propagating a RF transmission signal through the first waveguide to a bi-directional port without coupling a significant portion of the RF transmission signal to the second waveguide;
propagating a RF reception signal from the bi-directional port to the first waveguide;
coupling the RF reception signal from the first waveguide

to the second waveguide; and
propagating the RF reception signal from the second waveguide to an output port.

[c12] The method of claim 11 wherein the coupling the RF reception signal comprises coupling substantially all of the RF reception signal from the first waveguide to the second waveguide.

[c13] The method of claim 11 wherein the RF reception signal is received from an antenna.

[c14] The method of claim 11 wherein the first and the second traveling waves have fields that are substantially velocity matched to at least one of the RF reception signal and the RF transmission signal.

[c15] The method of claim 11 wherein the propagating the RF reception signal from the bi-directional port and the propagating the RF transmission signal through the first waveguide to the bi-directional port are performed substantially simultaneously in time.

[c16] The method of claim 11 further comprising converting a received optical transmission signal to the RF transmission signal.

[c17] An electro-optic bi-directional signal interface compris-

ing an electro-optic modulator having an optical input that receives an optical beam, a RF input port that receives a RF transmission signal, a RF bi-directional port that receives a RF reception signal and that transmits the RF transmission signal, and an optical output port, the electro-optic modulator generating an optical signal that is modulated by the RF reception signal at the optical output port and passing the RF transmission signal to the RF bi-directional port.

[c18] The signal interface of claim 17 wherein the optical beam comprises a continuous-wave optical beam.

[c19] The signal interface of claim 17 wherein the optical beam comprises a pulsed optical beam.

[c20] The signal interface of claim 17 wherein the electro-optic modulator comprises a Mach-Zehnder interferometric modulator.

[c21] The signal interface of claim 17 wherein the electro-optic modulator comprises an electrode structure that velocity matches the RF reception signal to an optical field of the optical beam.

[c22] The signal interface of claim 17 further comprising a photodetector having an optical input that receives an optical transmission signal and an electrical output that

is connected to the RF input port, the photodetector converting the received optical transmission signal to the RF transmission signal at the electrical output.

[c23] The signal interface of claim 22 further comprising an amplifier having an input that is electrically connected to the output of the photodetector and an output that is electrically connected to the RF input port, the amplifier electrically amplifying the RF transmission signal.

[c24] The signal interface of claim 17 wherein the RF bi-directional port receives the RF reception signal and passes the RF transmission signal substantially simultaneously in time.

[c25] The signal interface of claim 17 further comprising an antenna that is electrically connected to the bi-directional port.

[c26] The signal interface of claim 17 wherein the RF input port is terminated with a resistance in order to reduce a noise figure associated with a system using the signal interface.

[c27] A method of transmitting and receiving signals, the method comprising:
receiving a RF reception signal at a RF bi-directional port;

receiving a RF transmission signal at a RF input port;
generating an optical beam;
modulating the optical beam with the RF reception signal and passing the modulated optical beam to an output port; and
passing the RF transmission signal to the RF bi-direction port.

[c28] The method of claim 27 wherein the receiving the RF reception signal at the RF bi-directional port and the passing the RF transmission signal to the RF bi-directional port are performed substantially simultaneously in time.

[c29] The method of claim 27 further comprising velocity matching the received RF reception signal to an optical field of the optical beam.

[c30] The method of claim 27 further comprising generating the RF transmission signal from an optical transmission signal that is generated by an optical data signal source.

[c31] An electrical bi-directional signal interface comprising a distributed amplifier having a RF input port that receives a RF transmission signal, a RF bi-directional port that receives a RF reception signal and that transmits the RF transmission signal, and a RF output port, the distributed amplifier coupling the RF reception signal to the

RF output port in a substantially non-reciprocal manner and passing the RF transmission signal to the RF bi-directional port.

[c32] The signal interface of claim 31 wherein substantially all of the RF transmission signal passes to the RF bi-directional port.

[c33] The signal interface of claim 31 wherein the RF bi-directional port receives the RF reception signal and passes the RF transmission signal simultaneously in time.

[c34] The signal interface of claim 31 further comprising an antenna that is electrically connected to the RF bi-directional port.

[c35] A method of transmitting and receiving signals, the method comprising:
receiving a RF reception signal at a RF bi-directional port;
receiving a RF transmission signal at a RF input port; and
electronically coupling the RF reception signal to a RF output port in a non-reciprocal manner and passing the RF transmission signal to the RF bi-directional port.

[c36] The method of claim 35 wherein the receiving the RF reception signal at the RF bi-directional port and the pass-

ing the RF transmission signal to the RF bi-directional port are performed substantially simultaneously in time.

[c37] The method of claim 35 wherein the electronically coupling the RF reception signal to the RF output port comprises amplifying the RF reception signal.

[c38] A transceiver comprising:
an antenna that receives a RF reception signal and that transmits a RF transmission signal;
a laser that generates an optical beam at an output; and
an electro-optic modulator comprising an optical input port that is optically coupled to the output of the laser, a RF input port , and a RF bi-directional port that is electrically connected to the antenna, the electro-optic modulator receiving the optical beam from the laser, the RF reception signal from the antenna, and the RF transmission signal at the RF input port, the electro-optic modulator generating an optical signal that is modulated by the RF reception signal at an optical output port and transmitting the RF transmission signal with the antenna.

[c39] The transceiver of claim 38 wherein the electro-optic modulator comprises a Mach-Zehnder interferometric modulator.

[c40] The transceiver of claim 38 wherein the electro-optic

modulator comprises an electrode structure that velocity matches the RF reception signal with an optical field of the optical beam.

[c41] The transceiver of claim 38 wherein the RF bi-directional port of the electro-optic modulator receives the RF reception signal from the antenna and passes the RF transmission signal to the antenna simultaneously in time.

[c42] The transceiver of claim 38 further comprising a photodetector having an optical input that receives an optical transmission signal from an optical data source and an electrical output that is connected to the RF input port of the electro-optic modulator, the photodetector converting the received optical transmission signal to the RF transmission signal at the electrical output.

[c43] The transceiver of claim 42 further comprising an amplifier having an electrical input that is connected to the electrical output of the photodetector and an electrical output that is connected to the RF input port of the electro-optic modulator, the amplifier electronically amplifying the RF transmission signal.

[c44] The transceiver of claim 38 further comprising a demodulator that is coupled to the optical output of the elec-

tro-optic modulator, the demodulator demodulating the RF reception signal.

[c45] The transceiver of claim 42 further comprising an optical data source that generates the optical transmission signal.

[c46] A low-noise uni-directional signal interface comprising an electro-optic modulator having a traveling wave electrode structure that is terminated at one end by an impedance, an optical input that receives an optical beam, a RF input port that receives a RF reception signal, and an optical output port, the electro-optic modulator generating an optical signal that is modulated by the RF reception signal at the optical output port, wherein the traveling wave electrode structure reduces the noise figure associated with the signal interface.

[c47] A bi-directional signal interface comprising:
means for propagating a first traveling wave through a first waveguide and propagating a second traveling wave through a second waveguide;
means for propagating a transmission signal through the first waveguide to a bi-directional port without coupling a significant portion of the transmission signal to the second waveguide;
means for propagating a reception signal from the bi-

directional port to the first waveguide;
means for coupling the reception signal from the first waveguide to the second waveguide; and
means for propagating the reception signal from the second waveguide to an output port.